PCT/GB03/005452

Rec'd PCT/PTO 13 JUN 2005

#3

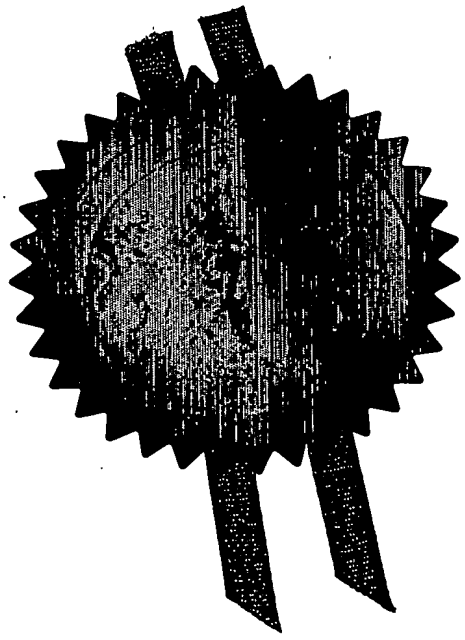
The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.



PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Signed

Dated 9 January 2004

Patents Form 1/77

Patents Act 1977
(Rule)

The Patent Office

13DEC02 E770735 D01038
P01/7700 0.00-0229056.7

1/77

THE PATENT OFFICE
13 DEC 2002
NEWPORT

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office
Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference P303616GB/PF

2. Patent application number *(The Patent Office will fill in this part)* 0229056.7 13 DEC 2002

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Meritor Heavy Vehicle Systems Limited
Rackery Lane
Llay
Nr Wrexham
Clwyd LL12 0PB
United Kingdom

Patents ADP number *(if you know it)* 07367410001

If the applicant is a corporate body, give the country/state of its incorporation: United Kingdom

4. Title of the invention: A Suspension Trailing Arm and Method of Making a Suspension Trailing Arm

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

WITHERS & ROGERS
Goldings House
2 Hays Lane
London
SE1 2HW

Patents ADP number *(if you know it)* 1776001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	11
Claim(s)	3 DMC
Abstract	
Drawing (s)	9 + 9

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	One ✓
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	Covering letter ✓

11. I/We request the grant of a patent on the basis of this application.

Signature W&V Date 11 December 2002

12. Name and daytime telephone number of person to contact in the United Kingdom — Paul Foot 0121 245 3900

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least six weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500 505.
b) Write your answers in capital letters using black ink or you may type them.
c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
d) If you have answered 'Yes' Patents Form 7/77 will need to be filed.
e) Once you have filled in the form you must remember to sign and date it.
f) For details of the fee and ways to pay please contact the Patent Office.

P303616GB

DUPLICATE

A Suspension Trailing Arm and Method of Making a Suspension Trailing Arm

The present invention relates to a suspension trailing arm and a method of making a suspension trailing arm. More particularly, the present invention relates to a cast suspension trailing arm and method of making a cast suspension trailing arm.

Heavy commercial vehicles typically employ trailing arm suspension systems, particularly in relation to rear axles of rigid body vehicles or the axles of trailers of articulated vehicles.

Heavy commercial vehicles (including trucks, buses and coaches) can be distinguished from light commercial vehicles (such as vans) and light passenger vehicles due to one or more of the following characteristics:

1. A laden weight in excess of approximately 3.5 tonnes.
2. The use of air actuated brakes as opposed to hydraulically actuated brakes (because air actuated brakes are more able to withstand the increased heat generated by the repeated braking of a vehicle having a weight in excess of approximately 3.5 tonnes).

Such vehicles (including trailers) also typically employ a pair of spaced parallel beams that run the length of the vehicle and act as the chassis upon which the vehicle body is mounted.

When used in heavy commercial vehicles the trailing arms are typically pivotally mounted to the chassis beams of the vehicle at the front of the arm, the arm extending rearwardly (i.e. towards the rear of the vehicle) to a mounting position for the axle and then further rearwardly to a mounting surface for an air spring, that is itself mounted between the trailing arm and vehicle chassis. Axles in such vehicles are typically substantially rigid beam-type axles. In some circumstances the orientation of the arms may be reversed so as to pivot at the rear of the arm, in which case they are known as

"leading arms". For the purposes of this specification the term trailing arm should also be understood to encompass leading arms.

Known heavy vehicle trailing arms are typically constructed either from solid spring steel trailing arms provided with U-bolts and plates to connect an axle to the arm, fabricated steel plate which is then welded to an axle or axle adapter, or a hybrid of the two aforesaid types. An example of a fabricated trailing arm is disclosed in US5639110 (Pierce et al.). Both prior art types seek to provide a rigid connection between the arm and axle in order to resist bending but have a resilient connection between the chassis axle, either by flexing of the spring steel trailing arm or by flexing of a large elastomeric bush (resilient bearing) in the end of a fabricated trailing arm. This enables articulation forces induced during vehicle use to be taken up whilst maintaining tracking and roll stability. It has typically been considered necessary in the case of fabricated trailing arms for use in heavy commercial vehicle applications for these to be manufactured having a closed box-section profile in order to impart sufficient tracking stability to the arm.

Two prime disadvantages have been identified in known trailing arm designs. Firstly, the known manufacturing techniques often place restrictions on the shape of the trailing arm, which in turn restricts the positioning of additional components that are mounted to the arms, such as brakes, air springs, dampers and pivot bushes. This may lead to the suspension packaging (i.e. its space requirement) being inefficient. Secondly, known types of trailing arm designs are time consuming and hence expensive to manufacture, either due to the welding or fastening of the various components that constitute the trailing arm together, or the fastening or welding operations required to secure the trailing arm to an axle.

The present invention seeks to overcome, or at least mitigate the problems of the prior art.

Accordingly, a first aspect of the present invention provides a cast suspension trailing arm for heavy commercial vehicles.

Preferably, a bracket for mounting a brake or a portion of a brake is cast therein. Advantageously, this simplifies the assembly of a suspension assembly incorporating the trailing arm.

A second aspect of the present invention provides a method of making a trailing arm for commercial vehicles comprising the step of casting the trailing arm.

A third aspect of the present invention provides a suspension trailing arm comprising a bracket for the mounting of a brake, or a brake part.

A fourth aspect of the present invention provides a suspension trailing arm for heavy commercial vehicles comprising a chassis mounting feature and an axle locating portion, wherein a section intermediate the mounting feature and axle locating portion has an open section profile comprising a web and at least one flange, the section having sufficient rigidity to resist lateral cornering forces.

Embodiments of the present invention are now described, by way of example only, with reference to the accompanying drawings in which:

FIGURE 1 is a side view of a typical heavy commercial vehicle;

FIGURE 2 is a perspective view of a prior art suspension assembly;

FIGURE 3 is a perspective view of another prior art suspension trailing arm;

FIGURES 4A and 4B are perspective views of a suspension trailing arm according to a first embodiment of the present invention;

FIGURES 5A to 5C are perspective views illustrating the assembly of a suspension trailing arm according to a second embodiment of the present invention;

FIGURES 6 and 7 are perspective views of a suspension assembly incorporating a suspension arm according to a third embodiment of the present invention;

FIGURES 8 to 10 are perspective views of a suspension trailing arm according to a fourth embodiment of the present invention;

FIGURES 11 to 13 are perspective views of a rear portion for attachment to the arm of Figures 8 to 10;

FIGURES 14 and 15 are perspective views of two arms of Figures 8 to 10 secured to an axle;

FIGURE 16 is a perspective view of the arms of Figures 14 and 15 with the rear portions of Figures 11, 12 and 13 secured thereto;

FIGURE 17 is a perspective view of a suspension assembly comprising the arm of Figures 8 to 10; and

FIGURE 18 is a perspective view of a suspension assembly incorporating a trailing arm according to a fifth embodiment of the present invention.

Figure 1 shows a heavy commercial vehicle 20 comprising a tractor portion 22 and a trailer portion 24 mounted for articulation relative to the tractor portion. A plurality of wheels 26 are suspended from a chassis 25 of the trailer portion so that the wheels rotate about axes 28.

Turning to Figure 2 in which a prior art suspension assembly 30 is shown, this briefly comprises a spring steel suspension arm 32, a chassis support bracket 34 and an air spring 36. The support bracket 34 and air spring 36 provide a connection with, and suspension relative to, the trailer chassis 25 (shown in broken lines for clarity) in a known manner. U-bolts 40 and top and bottom plates 41a and 41b provide a means of mounting an axle 42 (shown in broken lines for clarity) to the trailing arm 32. In

particular it should be noted that bottom plate 41b is welded directly to axle 42. Wheels (not shown) are secured to each end of the axle 42 for rotation about axis 28. A damper 44 mounted between support bracket 44 and U-bolt and plate assembly 40 is provided to damp oscillations of the axle 44 relative to the chassis 25 as the vehicle 20 drives over uneven ground.

A fabricated steel trailing arm 132 of a prior art design is shown in Figure 3 and comprises a bush 146 housing a resilient bearing (not shown) to enable the arm to be mounted to a chassis support bracket and an integrated axle wrap 148 to support axle 42 of the vehicle 20. The axle wrap 148 is first welded to the axle 42 around the periphery of openings 149 (only one visible in Figure 3, but two are present on the wrap 148) and the remainder of the arm is then welded to the axle wrap. The arm 132 is further provided with a surface 150 upon which an air spring (not shown) may be mounted.

It will be appreciated that for both types of prior art trailing arm described above, a considerable amount of assembly is required and a large number of components are needed to provide a complete suspension assembly.

Turning to Figures 4A and 4B, these show a trailing arm 232 according to a first embodiment of the present invention to which a conventional axle 42 is mounted (Figure 4A only). Such axles are typically capable of each carrying 6 or more tonnes of payload in use. The trailing arm 232 is cast as a single piece, having a front portion 252 and a rear portion 254 separated by an axle locating portion in the form of a cast axle wrap 256 dimensioned to receive the axle 42 therethrough.

The leading end of the front portion 252 is cast so as to provide a bearing mounting 246 to receive a resilient bearing (not shown) that mounts the trailing arm 232 to a chassis support bracket (not shown) in a similar manner to the prior art.

Intermediate the axle wrap 256 and bearing mounting 246, the front portion 252 is cast with an I-section profile to provide an optimum strength to weight ratio for the arm 232.

The rear portion 254 is provided with an upwardly facing substantially planar surface 250 upon which an air spring (not shown) may be received. Through holes 251 may further be provided on surface 250 in order to securely locate the air spring on the surface by the use of bolts therethrough, for example. A downwardly extending web 253 may be provided therein so to form a shallow T-section and impart sufficient strength to this portion of the arm 232. In other embodiments the rear portion 254 may be an I-section or box section, for example.

Openings 258 are preferably provided in the cast wall that constitutes the axle wrap 256. The openings enable the axle 42 to be securely ring or fillet welded to the trailing arm 232 around the edge of the openings 258 to ensure a secure connection between the two components. A similar opening 259 is provided on the opposite side of the wrap 256 for a similar purpose.

The arm 232 may be cast using any suitable casting process and may be cast from any suitable material having sufficient strength and durability properties for this particular application, such as cast iron or cast steel. One advantage of cast steel is that the weldability of the arm is improved. In some embodiments surfaces of the arm 232 are machined to provide a suitable surface finish for fitment to the axle or other components, or to remove any stress raising surface contours.

Referring to Figures 5A to 5C, a second embodiment of the present invention is illustrated in which like parts have been designated where possible by like numerals with respect to Figure 4 but with the prefix "2" being replaced by the prefix "3". Only differences with respect to the trailing arm of the first embodiment will therefore be described in further detail.

It can be seen that in this embodiment the front portion 352 is cast as a separate piece from the rear portion 354. Thus, the axle wrap is constituted from two separate halves 356a of front portion 352 and 356b of rear portion 354. As in the first embodiment, openings 358 and 359 are provided. The openings permit each wrap half 356a and 356b to be independently plug welded to the axle 42. It can be seen that in Figure 5B

front portion 352 is first welded to the axle 42, this is subsequently followed by the rear portion 354. However, in alternative embodiments the rear portion is welded on first, or both the front and rear portions 352 and 354 are welded directly to each other along mating edges 360 prior to being welded to the axle. These edges 360 may be angled so as to provide a notch (not shown) in which the welding material may solidify. In a preferred embodiment, the front and rear portions are welded together whilst in situ around the axle and the welds are allowed to cool before the arm is welded to the axle via openings 358 and 359. This welding method has been found to improve the durability of the connection between arm and axle.

One advantage of the arm 332 of this embodiment is that it may be simpler to cast in two parts as opposed to a single part. Furthermore, the mating of the two parts around the axle 42 means that it is not necessary to slide the axle through the axle wrap 256 for assembly as is the case with the first embodiment.

Turning now to Figures 6 and 7 a third embodiment of the present invention is illustrated and, as before, like numerals where possible designate like parts, but with the with the prefix "3" being replaced by the prefix "4".

In this embodiment a further variant of trailing arm 432 is illustrated in situ in a suspension assembly 430. The arm 432 is cast as a single piece and is pivoted at its leading end to a chassis support bracket 434 by a bearing (not visible) mounted in housing 446. A damper 444 extends between the bracket 434 and a mounting feature in the form of a mounting hole 472 provided in the front portion 452 of the arm.

Additionally, it can be seen that axle wrap 456 is provided with an extension 362 in a direction outwardly towards the end of the axle and a bracket 464 is cast integrally therewith in a direction radially outwardly from the wrap to enable a carrier portion 466 of a disc brake to be secured thereto by bolts 472. In turn, a floating caliper 468 of the disc brake is mounted to the carrier 466 for movement parallel to axis 28, as is well known. A brake actuator 470 is secured to the caliper 468 and is arranged to float along with the caliper. It should be noted that the lower flange portion 474 of the front

portion 452 of the trailing arm has a raised concave portion to accommodate the actuator 470 and is cut away to accommodate the caliper (when the friction material of the brake is worn), thus optimising the space in the vehicle taken up by the suspension assembly and brake.

It will be appreciated that by providing a bracket 464 for mounting a brake that is cast integrally with the trailing arm 432, the part count and assembly time of the suspension, brake and axle assembly may be reduced, leading to cost savings in the manufacture and assembly of a vehicle 20 to which they are fitted. Additionally the arrangement reduces the number of components that need to be welded directly to the axle, thus potentially increasing its service life. Furthermore, the integration of the various parts may reduce the unsprung mass of a vehicle leading to improvements in handling and ride comfort.

In a further development of the trailing arm, a brake carrier itself or part of a brake carrier, may be cast integrally with the trailing arm further reducing the part count of the overall assembly.

In other classes of embodiment, the bracket for mounting a brake or brake part may be secured to or formed in suspension trailing arms that are not cast. Rather, the bracket or brake part may be welded or otherwise secured to a fabricated or spring steel arm, or extension thereof. For example, the axle wrap of a fabricated trailing arm may be adapted to include a bracket or brake component.

An arm 532 according to a fourth embodiment of the present invention is shown in Figures 8 and 9 in which like numerals are designated by like parts but with the prefix "4" being replaced with the prefix "5". The arm 532 is similar to that of the first embodiment of Figures 4A and 4B except that a cast rear portion for receiving the air spring is omitted (but the wrap 556 is cast as a single piece, and in that the arm has a C-section profile rather than an I-section.

It should be noted that one advantage of using a C-section profile is that the potential is increased to cut away a greater portion of lower flange 572 in order to permit more travel of a disc brake caliper away from the wheel when the friction material of the brake is worn (because the web is further inbound than for I-section profiles). It should be noted that in this embodiment vertical stiffening members 574 are provided between the lower flange 572 and the upper flange 576 in order to improve the structural integrity of the C-section.

A thickened boss 575 is also cast in the front portion that is drilled through to act as a mounting for a damper (see Figure 17).

It should be noted that whilst the entire axle wrap 556 is cast integrally with the arm, a separate fabricated rear portion 554 as shown in Figures 11 to 13 is provided so as to be welded to the axle wrap 556 once this has been secured to axle 42 by ring or fillet welding openings 558 and 559 (see Figures 15 to 17). It can be seen that the rear portion 254 comprises upper and lower sheet portions 578 and 579 interconnected by spaced side walls 580 thereby forming a curved box section with a surface 550 arranged to receive an air spring 536 (see Figure 20). In alternative embodiments, half of axle wrap 556 may be cast integrally with the arm, with the other half being attached to the fabricated rear portion 554 as a cast or fabricated half. It should also be appreciated that other forms of fabricated rear portion may be used. For example, bottom plate 579 may be omitted or the portion may be fabricated to form an I or T-section for example.

Turning to Figure 17, one suspension assembly 530 is shown and comprises axle 42, arm 532, mounting bracket 534, a damper 544 mounted between the arm and the bracket, air spring 536, a brake carrier 566 mounted on a bracket 564 (see Figure 16) and to which a caliper 568 and actuator 570 are mounted. It can be seen that the front portion 552 is cranked to provide more space between it and the brake and wheel and that actuator 570 fits within the raised portion of lower flange 572 and that space is provided by the cut out section of lower flange 572 to accommodate the sliding of caliper 568. It can further be seen that a wheel hub 582 is rotatably mounted to the end of axle 42 and that a brake disc or rotor 584 is secured to the hub 582 to be straddled

and received by brake caliper 568. It can be seen that the arrangement of the arm 532 provides more space for accommodating the brake caliper 568 and actuator 570 and/or enables a narrower track wheel to be fitted to a vehicle having a standard spacing between the longitudinal chassis members 25.

Figure 18 illustrates a further embodiment of the present invention which is similar to the first embodiment of Figures 4A and 4B except that the surface 650 for receiving the air spring 636 is higher relative to the axle wrap 656 and axis 28 of the axle. This arrangement thus provides a "top mount" layout for the suspension which has a higher ride height for a given air spring compared with the first embodiment.

Although the forgoing description has been in relation solely to cast trailing arms having C- or I-section profiles, it is envisaged that these and other open section profiles (eg T-section) profiles may have advantages when employed in relation to fabricated or other types of trailing arm. Such profiles would require a web and at least one flange to impart sufficient strength to the arm. However, the location of the web further inboard in relation to the end of an axle to which the arm is secured in comparison with box-sections provides more room for the fitment of other components, specifically braking components. This is particularly the case if a portion of the lower flange is cut away. Furthermore, whilst such profiles provide sufficient tracking stability (i.e. are sufficiently resistant to lateral forces induced during cornering), they may be more compliant torsionally along their length. This means that smaller resilient bearings may be required to accommodate such torsional loads.

It should be understood that terms such as front, rear, top and bottom as used herein to describe the orientation of the various components are for illustrative purposes only and should not be construed as limiting with respect of the orientation in which the trailing arm may be fitted in a particular vehicle. It should be understood that arms according to the present invention may also be used as leading arms in which the mounting bracket is arranged aft of the air spring on a vehicle.

It will further be appreciated that numerous changes may be made within the scope of the present invention. For example, the trailing arm may be provided with an integral bracket for the fitment of drum rather than disc brakes, or an integral cast drum brake component may be provided on the arm. The arm may be adapted for use with alternatives to air springs, such as coil springs, for example, and may fitted to monocoque-type chassis. Additional features may be cast into the arm such as height control valve mountings and mountings for ABS and other sensors. The arm may be cast from three or more pieces should this be desirable, or if a particular design of arm necessitates further cast pieces. The cast pieces may be secured together by other means such as bolts. The bracket for mounting a brake may be non-cast (e.g. fabricated). The arm may be adapted to receive non-circular (eg square) axles and may mount stub as well as beam axles.

Claims

1. A cast suspension trailing arm for heavy commercial vehicles.

2. A trailing arm according to Claim 1 wherein an axle locating portion is cast therein.

3. A trailing arm according to Claim 1 or Claim 2 wherein the arm is provided with a feature to facilitate the mounting of the arm to a chassis component of a vehicle.

4. A trailing arm according any Claim 3 when dependent on Claim 2 wherein a section intermediate the mounting feature and axle locating portion has an open section profile.

5. A trailing arm according to Claim 4 wherein the open section profile is a C- or I-section profile.

6. A trailing arm according to any one of Claims 2 to 4 wherein openings are provided in the axle locating portion to permit the arm to be ring or fillet welded to an axle.

7. A trailing arm according to any preceding Claim in which a bracket or surface for an air spring is cast therein.

8. A trailing arm according to any preceding Claim wherein a damper locating feature is cast therein.

9. A trailing arm according to any preceding Claim wherein a bracket for mounting a brake is cast therein.

10. A trailing arm according to any one of Claims 1 to 8 wherein a portion of a brake is cast therein.

11. A trailing arm according to any preceding Claim cast as a single piece.

12. A trailing arm according to Claim 11 wherein a separate non-cast bracket for mounting a brake and/or a non-cast surface for receiving an air spring is provided.

13. A trailing arm according to any one of Claims 1 to 10 cast in separate first and second pieces.

14. A trailing arm according to Claim 13 wherein the first piece is a front portion.

15. A trailing arm according to Claim 13 or 14 wherein the second piece is a rear portion.

16. A trailing arm according to Claim 15 when dependent upon Claim 14 wherein the front and rear portions are arranged so as to be jointed together at an axle mounting location.

17. A suspension assembly comprising two trailing arms according to any preceding Claim and an axle.

18. A heavy commercial vehicle trailer comprising a trailing arm according to any one of Claims 1 to 16.

19. A method of making a trailing arm for heavy commercial vehicles comprising the step of casting the trailing arm.

20. A method according to Claim 19 wherein the trailing arm is cast as a single piece.

21. A method according to Claim 19 wherein the trailing arm is cast in first and second pieces and the method comprises a further step of assembling the first and second pieces.

22. A method according to any one of Claims 19 to 21 further comprising the step of securing the trailing arm to an axle.

23. A method according to any one of Claims 19 to 22 wherein the casting step further includes the casting of an integral bracket for the mounting of a brake or integral casting of a brake component.

24. A suspension trailing arm comprising a bracket for the mounting of a brake, or a brake part.

25. A suspension trailing arm according to Claim 24 comprising a bracket for mounting a disc brake carrier.

26. A suspension trailing arm according to Claim 24 comprising at least a portion of a disc brake carrier.

27 A suspension trailing arm for heavy commercial vehicles comprising a chassis mounting feature and an axle locating portion, wherein a section intermediate the mounting feature and axle locating portion has an open section profile comprising a web and at least one flange, the section having sufficient rigidity to resist lateral cornering forces.

28 A suspension trailing arm according to claim 27 wherein the open section profile is an I- or a C-section.

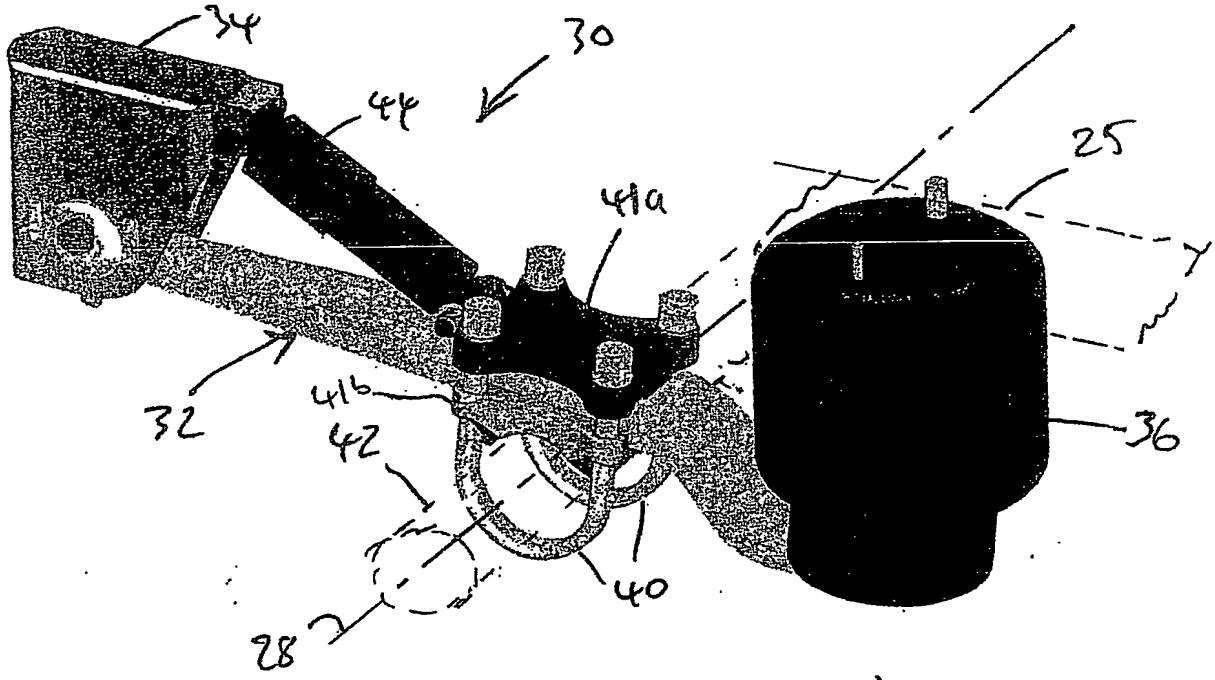


FIG. 2 (PRIOR ART)

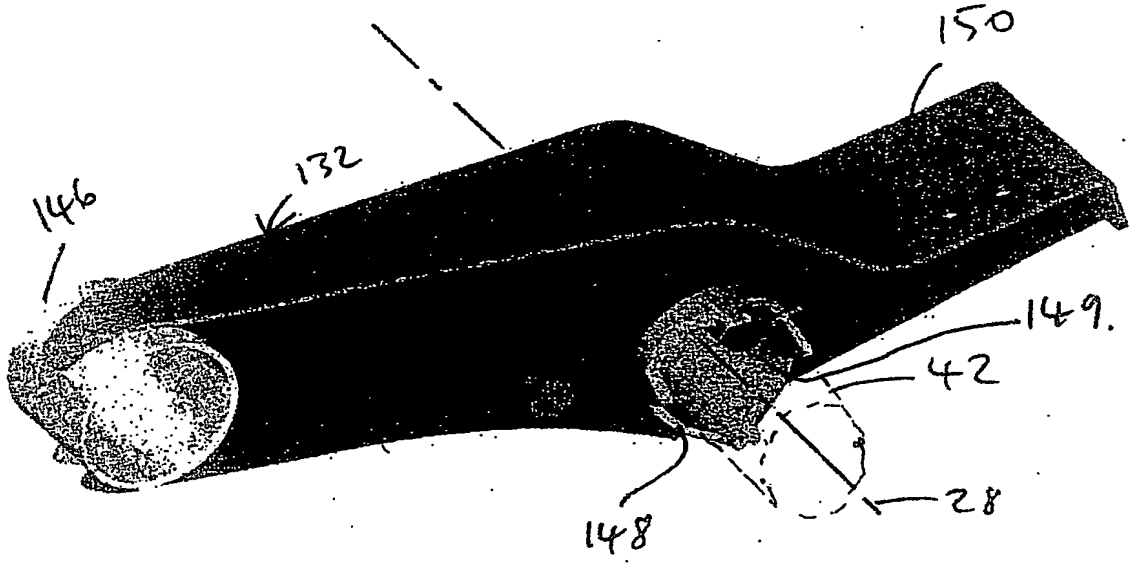


FIG. 3 (PRIOR ART)

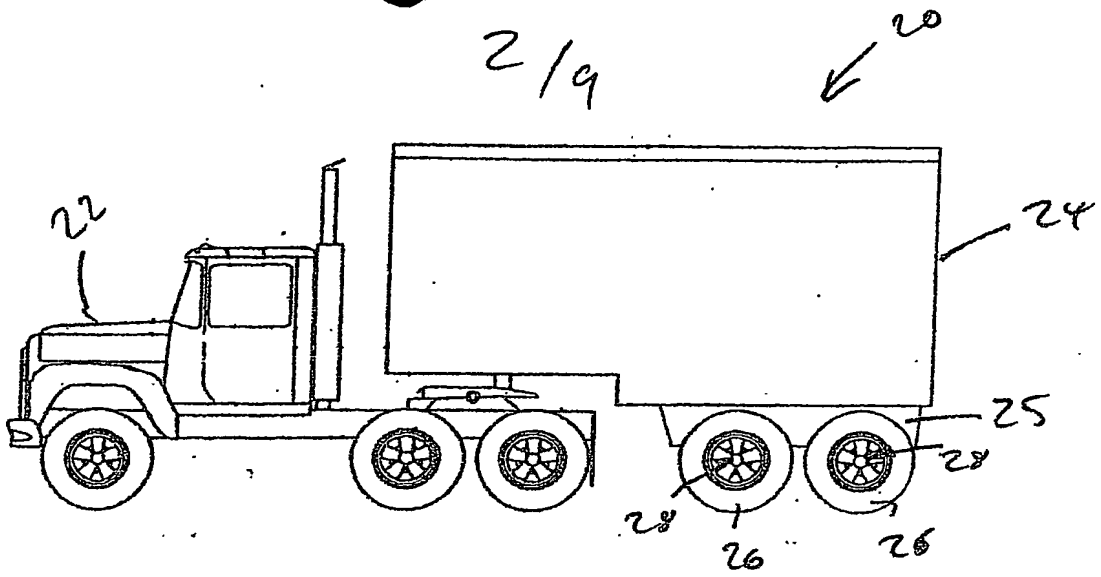


FIG. 1

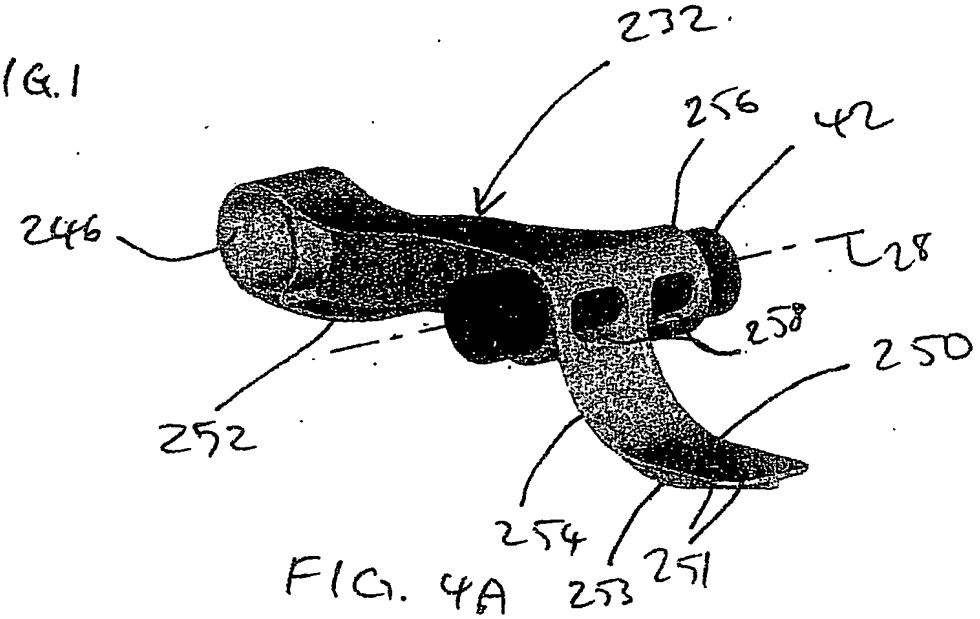


FIG. 4A

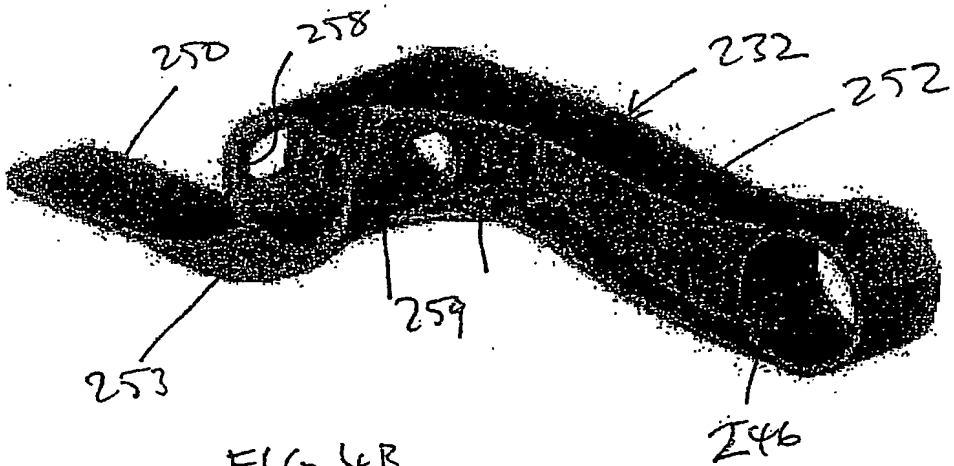


FIG 4B

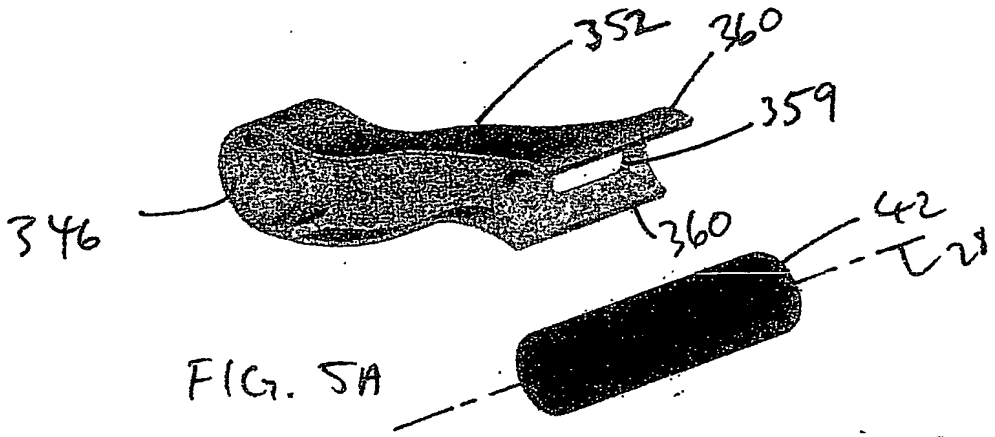


FIG. 5A

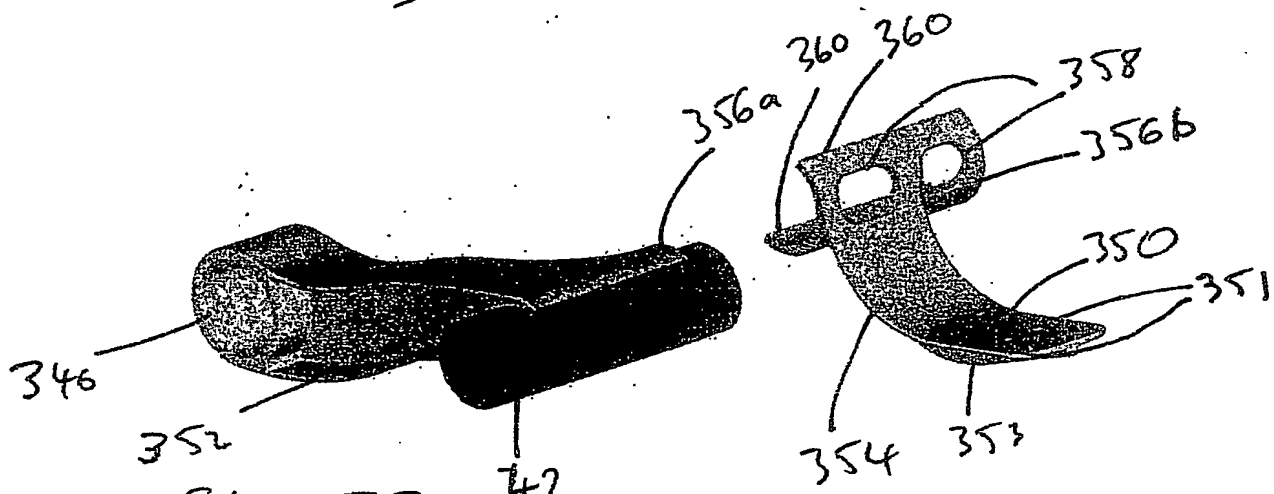


FIG. 5B

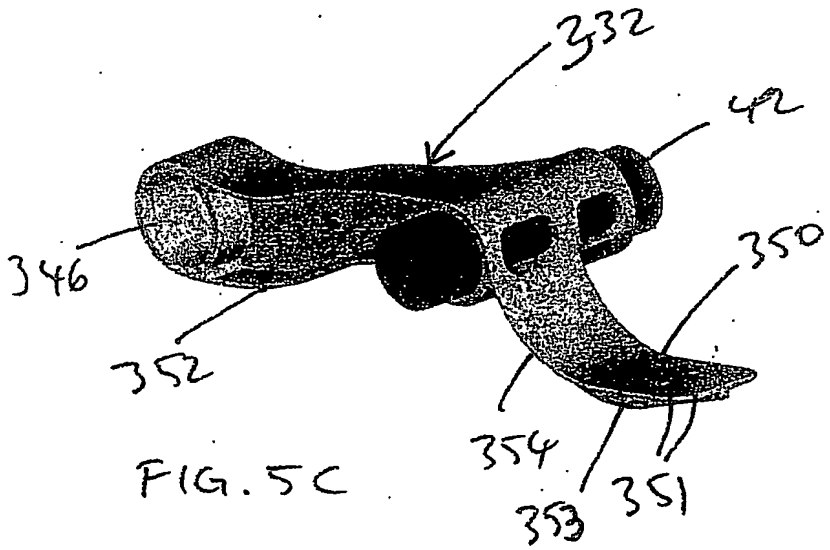


FIG. 5C

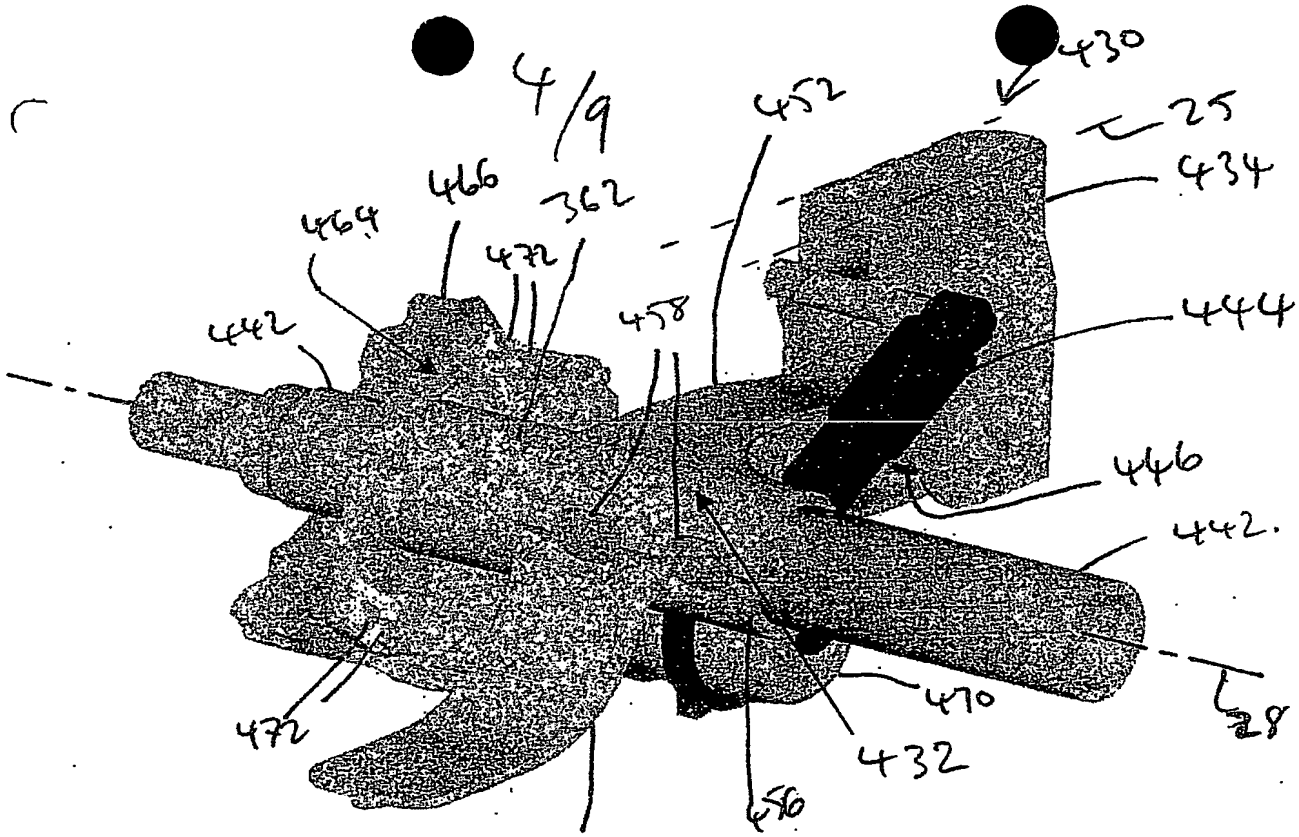

430
452
25
434
466
362
464
472
458
442
444
446
442
470
472
432
456
454

FIG. 6

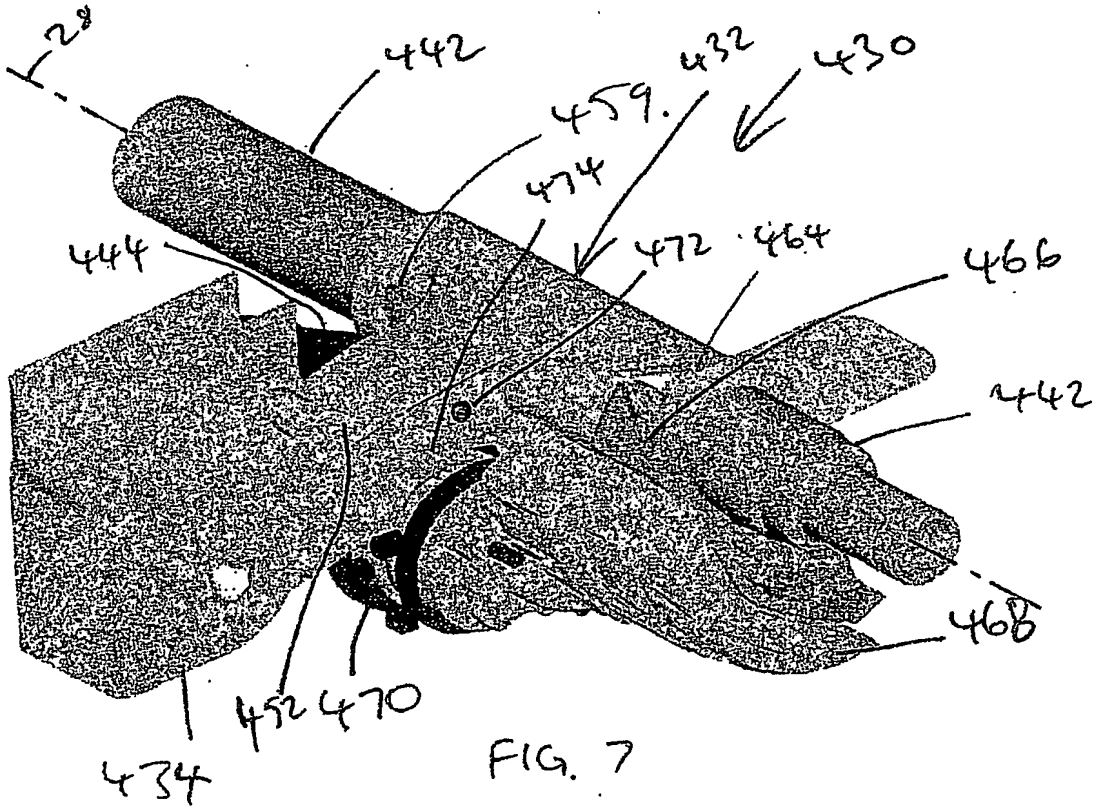

28
442
459
432
430
474
444
472
464
466
442
468
452
470
434

FIG. 7

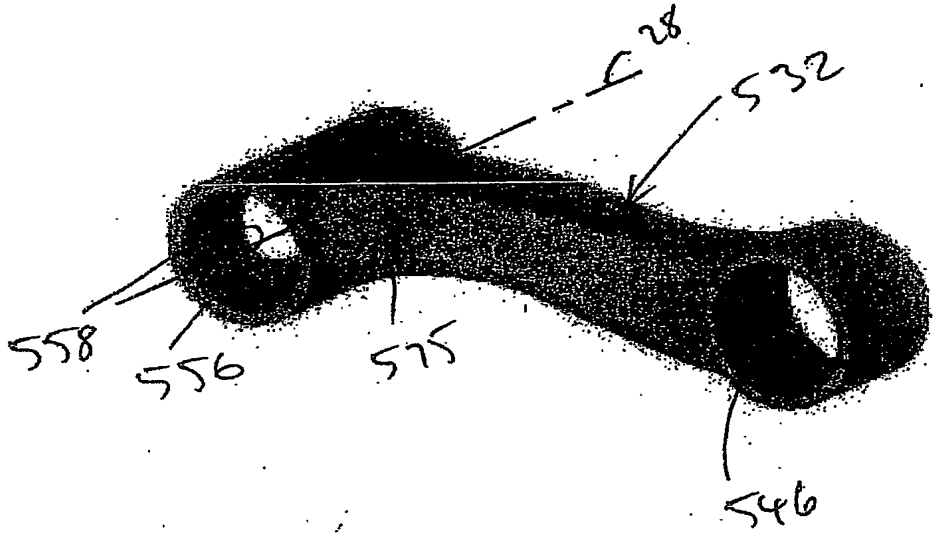


FIG 8

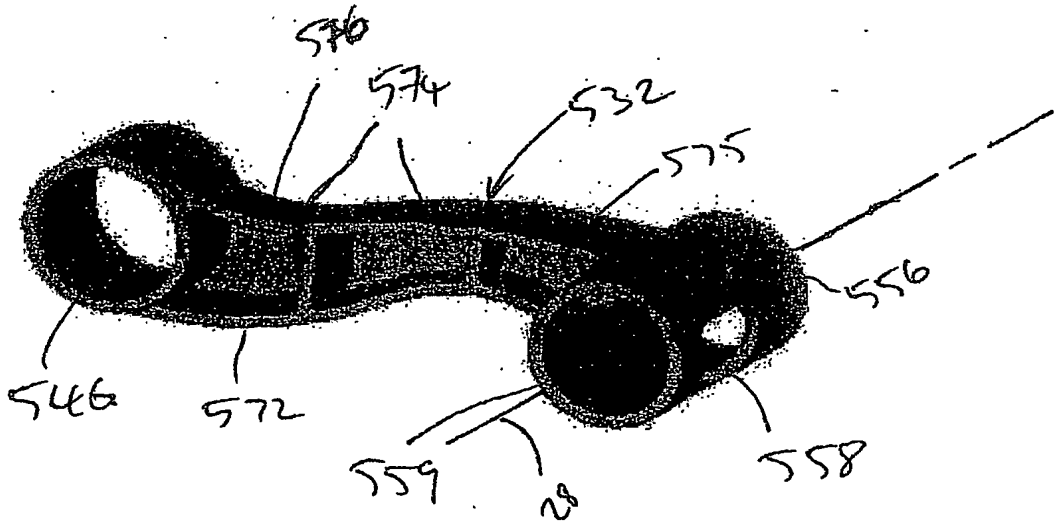


FIG 9

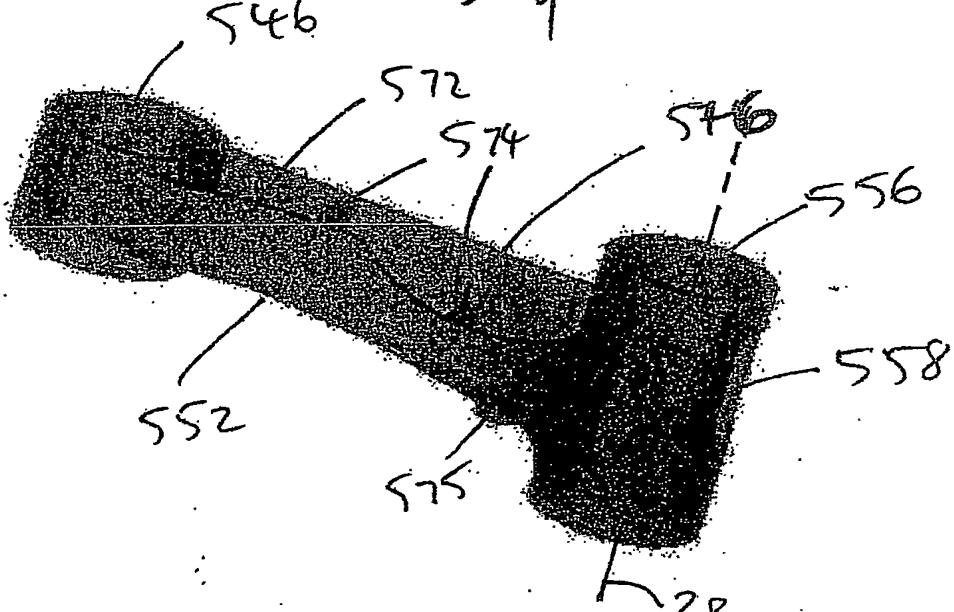


FIG 10

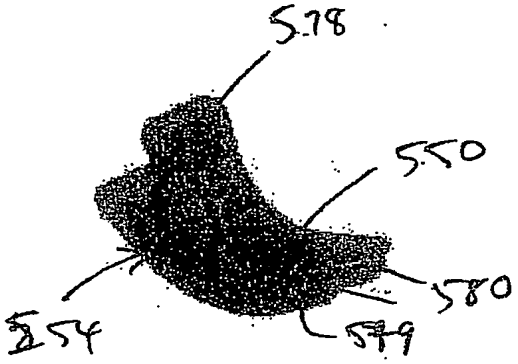


FIG 11

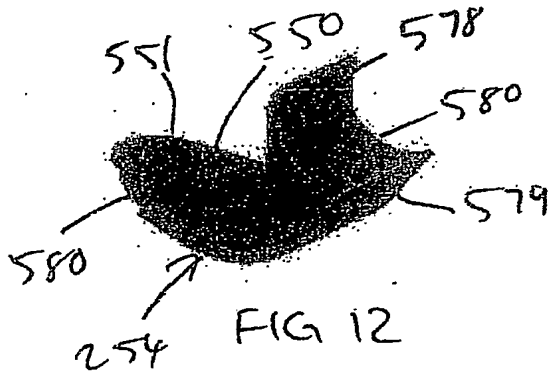


FIG 12

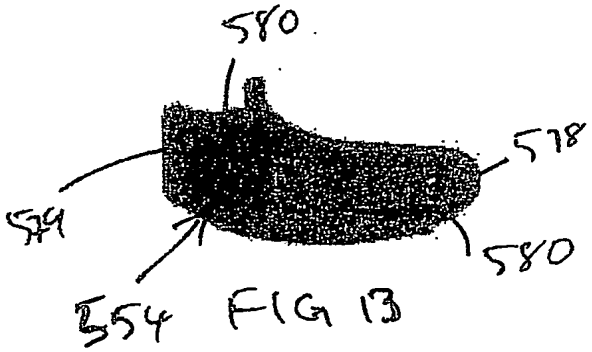


FIG 13

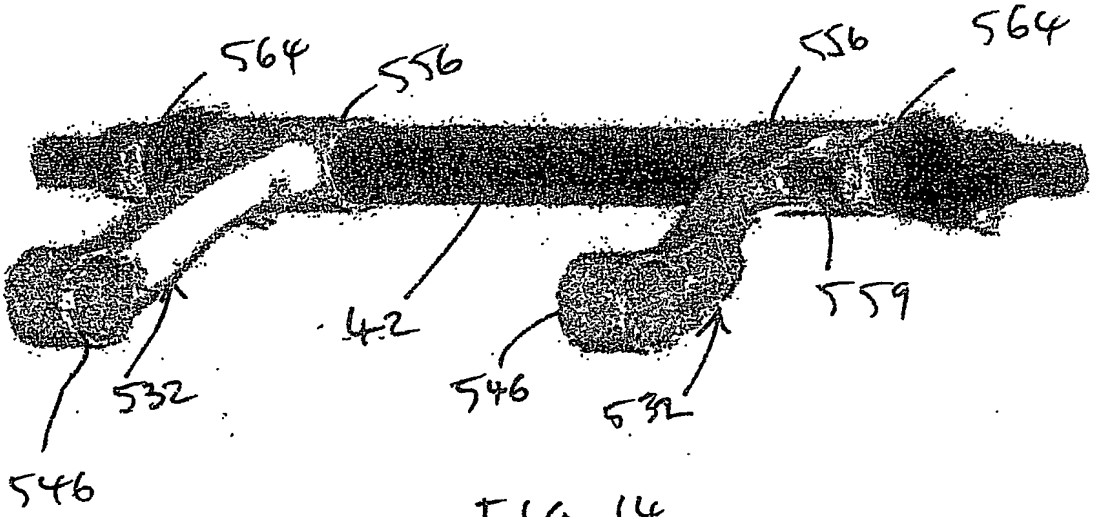

564
556
556
564
559
42
532
546
532
546

FIG. 14

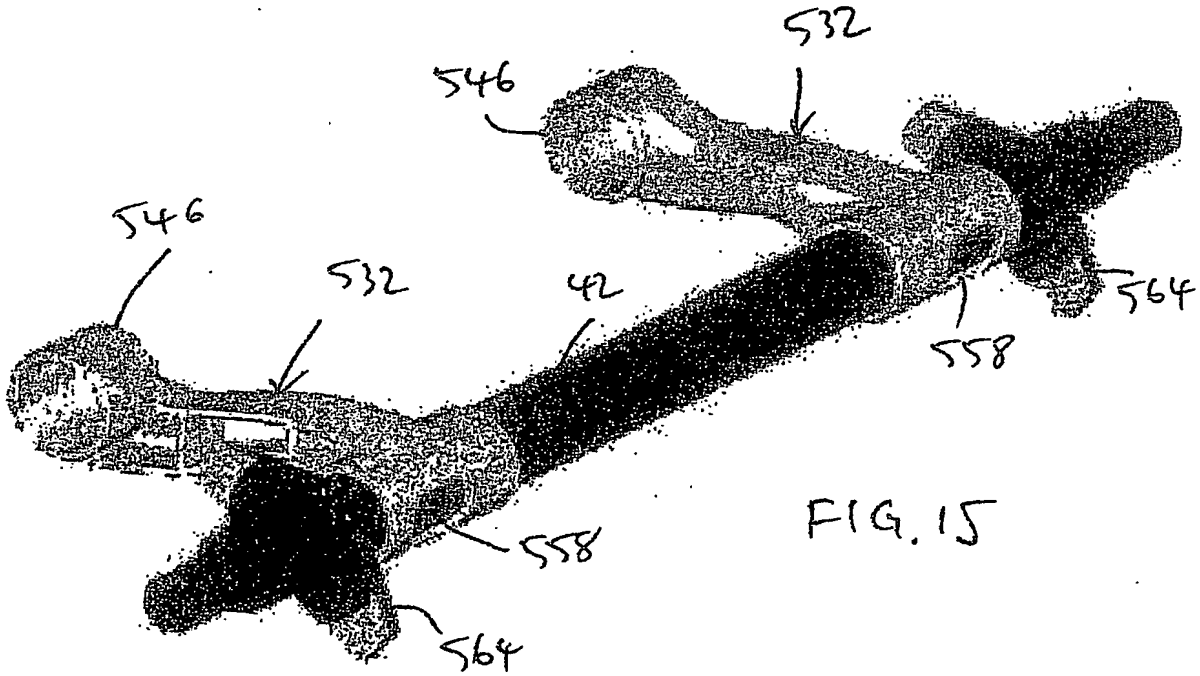

532
546
546
532
42
564
558
558
564

FIG. 15

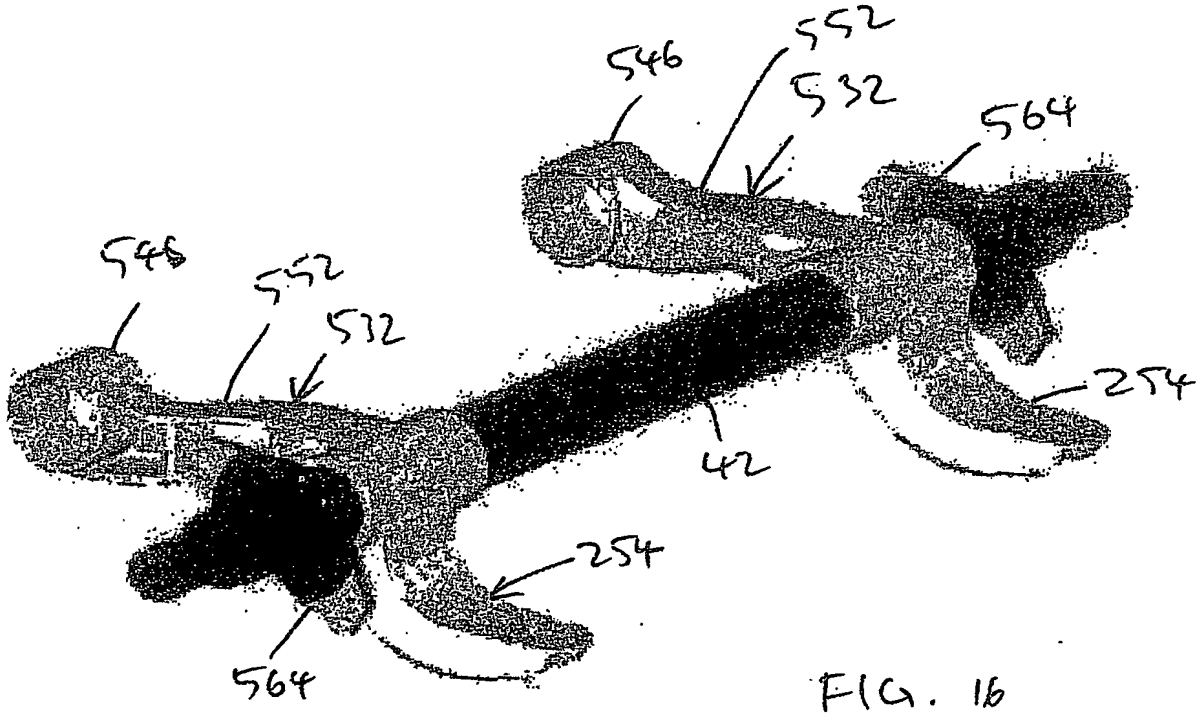

546
552
532
564
548
552
532
254
42
254
564

FIG. 16

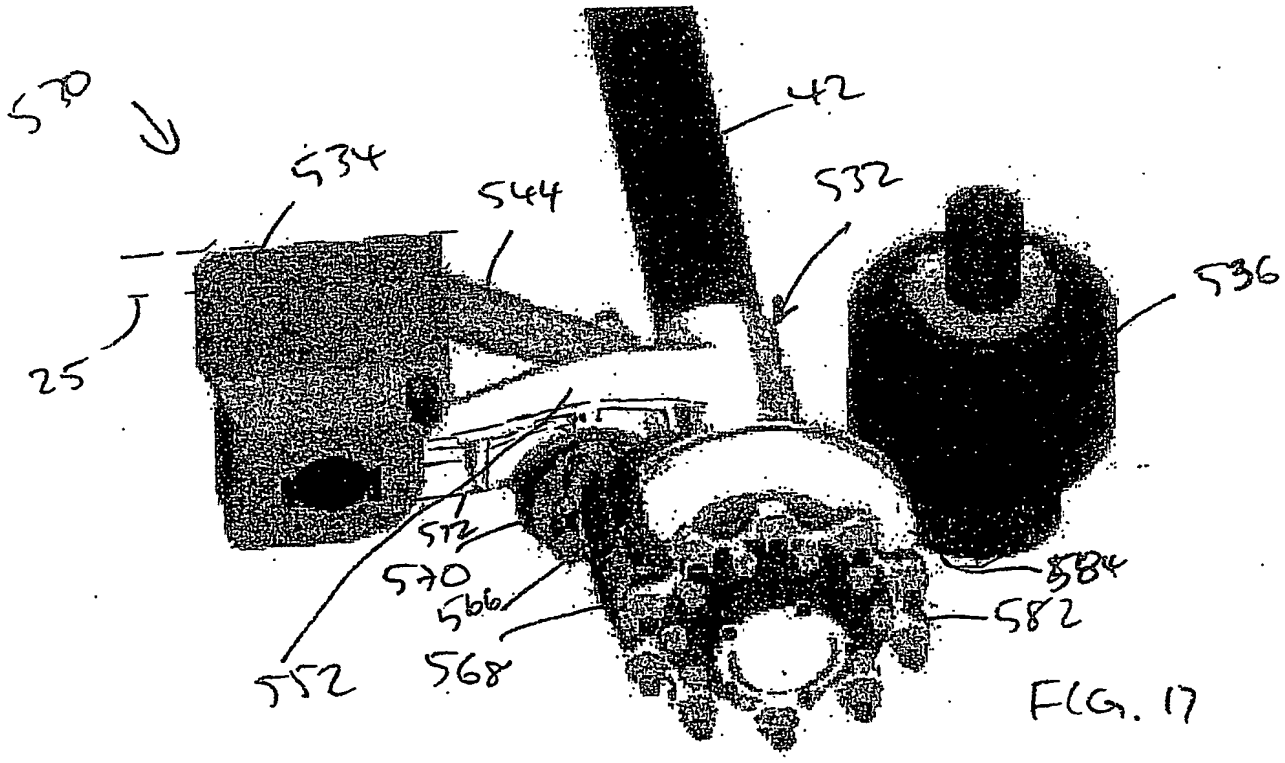

570
534
544
532
42
536
25
572
570
566
568
552
584
582

FIG. 17

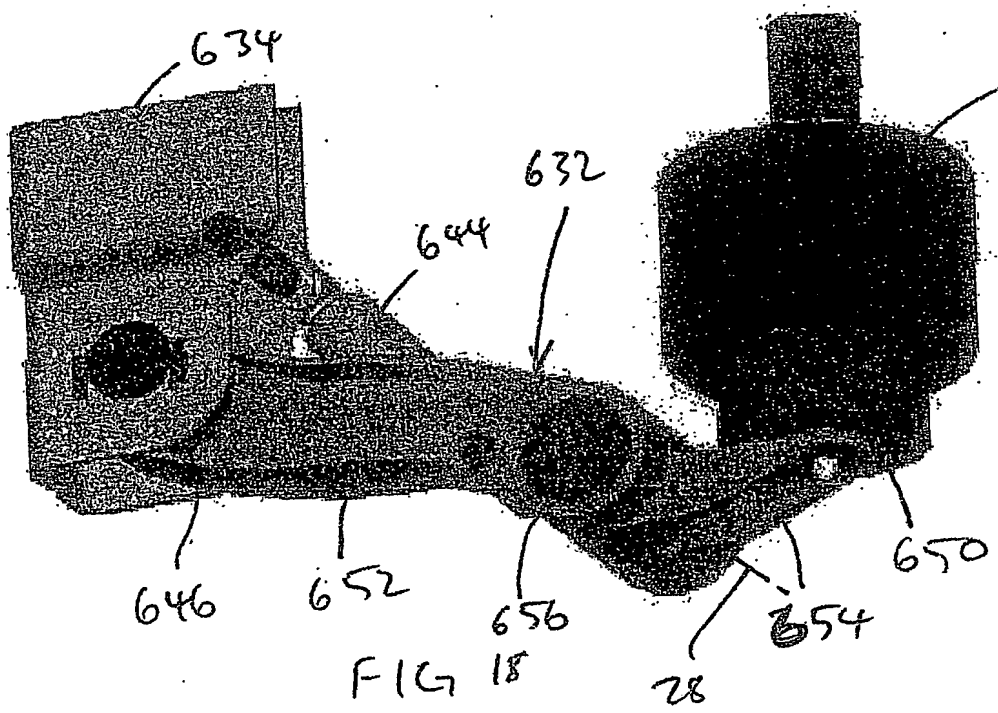


FIG 18